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ABSTRACT

The digest summarizes major characteristics of American Indian student needs in the disciplines of science and math and offers constructive ways in which students may be motivated for greater achievement. Motivational, attitudinal, and behavioral factors contributing to avoidance of science and math by American Indian students are identified: conflicts between home and school regarding the purpose/importance of school; movement away from lessons in context and interdisciplinary approaches toward more structured and linear approaches in junior high; and a social organization of lesson presentation which is less group oriented and more authoritarian. Characteristics of American Indian students' learning styles which may affect science and math motivation are outlined: seeing and listening, practicality, caution, and field sensitive orientation. Suggestions for teaching science and math as creative processes and cultural systems of knowledge include: deriving creative content from students' immediate environment; integrating contemporary American Indian issues and concerns with related scientific information; utilizing American Indian culturally based content; establishing learning situations which are experientially based; incorporating creative writing as part of the presentation of science and math content; presenting art as an ideal vehicle for creativity in science and math; and exploring effects of technology on human lifestyles. (NEC)

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# AMERICAN INDIAN EDUCATION

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## MOTIVATING AMERICAN INDIAN STUDENTS IN SCIENCE AND MATH

Many American Indian students drop high school math and science courses which are not specifically required for graduation. These students do not acquire the necessary science and math skills enabling them to pursue scientific or technical careers. This digest will summarize the major characteristics of American Indian student needs in the disciplines of science and math and then offer constructive ways in which they may be motivated for greater achievement.

**What are some of the causes for the lack of American Indian student achievement in science and math?**

The lack of achievement of American Indian students in science and math reflects a larger problem of underachievement of all students in these areas nationwide. Critics charge that the national problem of student underachievement in science and math is primarily the result of curricula which lack focus and fail to challenge students. In addition, many concepts are simply repeated from one year to the next without building on them. Despite this, many American Indian students show early potential for success in science and math. Relatively high scores on standardized tests in kindergarten through fourth grade indicate that most American Indian students are able to learn the elementary concepts and skills in those areas (Proceedings, 1983; Rossman, 1983).

However, by the time they reach junior high many American Indian students avoid science. This avoidance appears to result from an interplay of motivational, attitudinal and behavioral factors. Some of the factors which may contribute to such avoidance are: 1) conflicts between home and school regarding the purpose and importance of school; 2) an abrupt movement away from lessons in context and interdisciplinary approaches to teaching science and math in earlier grades toward more structured and linear approaches in junior high; and 3) a social organization of lesson presentation which is less group oriented and more authoritarian (Leap, 1982). Other explanations cited are that many American Indian students possess a cultural world view that is significantly different from American society at large. This, in turn, affects their perceptions and receptiveness to science and math. Additionally, many American Indian students tend to have unique learning characteristics by which the perceive and process information. Therefore, a different approach is required in presenting science and math content (Cajete, 1986).

**What are some of the important areas which need to be considered in the development of motivational tools for American Indian students in science and math?**

Linguistic differences of American Indian students can add to the problems which they encounter in science and math. Linguistic problems revolve around science curricula which place great emphasis on reading, writing and understanding of technical science jargon. This especially appears to be the case if the student comes from a predominately native language speaking background. Most American Indian languages do not categorize or abstract the same as English. As a result, many concepts in science are not readily translatable into those languages. Consequently, learning science or math becomes not only a problem of acquiring new words but also one which requires learning an entire specialized language (Schindler and Davison, 1985).

A traditional philosophy based on adaptation to nature and on a practical, experimential perspective of living within the environment can seem to oppose "school" science in the minds of some students and teachers. Yet, American Indian languages and cultural heritage are filled with descriptive examples of practical experience and knowledge which personify an intimate understanding of natural phenomena. It is possible to use such cultural understanding of nature to enhance American Indian student motivation in science and math courses. The key to such situations is facilitating the attitude among American Indian students that they can accomodate both perspectives. This allows students to see how their traditional and practical experience can be integrated into the more formal content approach of "school" science (Cajete, 1986; Marinez and Ortiz de Montellano, 1983).

Underpreparation of many teachers in elementary science and lack of cultural relevance have often been cited as problems which contribute to the lack of motivation of American Indian students. Such situations have tended to condition students to expect "boring" science and math classes and to believe that American Indian culture has nothing in common with science and math education. Therefore, increased preparation combined with cultural sensitivity on the part of science teachers must become an obvious priority (Cornell, 1985).

A large proportion of science teachers and schools view science and math education from a content perspective and consequently adopt content oriented and competency based science and math curricula. Sole emphasis on this content competency without an understanding of the learning and thinking process can further manifest problems in reference to the sociocultural dimensions of science and math education (Cornell, 1985).

**What are some major charactristics of American Indian students' learning styles which may affect their motivation in science and math courses?**

1. Seeing and Listening. Historically, many aspects of American Indian culture were treansmitted orally and visually through stories, ritual, art and practical example. This created a necessity for developing auditory learning, obervation and memory through storytelling, oratory and experiential learning. Since these approaches are still part of the informal education of many American Indian students, they should receive serious consideration to enhance motivation in science and math.

2. Practicality. Many American Indian students tend to be utilitarian oriented and thus have less difficulty understanding science/math concepts which are concrete or experiential. However, this does not mean that American Indian students are incapable of relating to abstract theory. For greater effectiveness, the teacher should begin with concrete examples and practical applications which lead to the abstract. In addition, emphasis should be placed on course content which is functional and relevant to daily living.

3. Caution. Many American Indian students tend to be cautious when faced with unfamiliar situations or activities. Such caution generally arises from learned behavioral patterns which make them sensitive to the reactions of others. Therefore, to the extent possible, class presentations should be made informal and open. Friendliness and sincerity on the part of the teacher are key factors in easing self-consciousness.

4. Field Sensitive Orientation. Many American Indian students express field-sensitive behavioral tendencies in reference to social interactions. These tendencies directly implicate certain learning modalities. Some important implications are: (a) the tendency to respond more readily to personal encouragement and guidance from the teacher, (b) the tendency to base motivation for learning on an affective relationship with the teacher and; (c) the tendency to respond favorably to learning formats which begin with group orientation (Cajete, 1986).

**Why is it important to teach science and math as creative processes and cultural systems of knowledge?**

Every cultural group has developed a world view based on certain perspectives in relation to the natural world. Included in this perspective is a philosophy and technology for the application of knowledge about the natural world. Likewise, mathematics is a cultural system which springs from a cultural group need to "count", "quantify", "manipulate" and "calculate" those things which that culture values. Yet this dimension is rarely addressed in science and math curricula (D'Ambrosio, 1986).

Science and math in the final analysis are also process oriented thinking strategies. At every turn, both involve a creative exploration of natural phenomena and practical problem solving. Creativity in both disciplines follows a discernable pattern, beginning with learning the basics, practicing, internalizing, taking apart and reassembling for greater synthesis and understanding. This process "ideal" is implied in the scientific method and mathematical problem-solving. Creative teaching in this respect involves facilitating creative thinking abilities through content which is both personally and culturally relevant to American Indian students (Cajete, 1986). This can be accomplished in a number of ways. Some possibilities include:

1. Deriving creative content from the immediate environment of the student. The student's backyard provides the first link of relevance in the gathering of data. The idea is to make "the common place" the "creating place" for both student and teacher. Contexts, situations and phenomena in the immediate environment, the home, community or school are all sources for gleaning scientific content (Cajete, 1986).

2. Integrating contemporary American Indian issues and concerns with related scientific information. Areas such as health, natural resource management, ecology, self determination, tribal government, history and

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relevant social issues provide a wealth of content for exploration and discussion which is socially and scientifically relevant (Cajete, 1986).

3. Utilizing American Indian culturally based content. Activities such as field trips, the study of artifacts or ethnographic information and guest speakers can provide descriptive examples which personify American Indian knowledge of nature while illustrating concepts in science and math. American Indian cultural content can be developed through discussions and projects in astronomy, psychology, botany, medicine, nutrition, agriculture, architecture, engineering and many other science related fields (Cajete, 1986; Marinez and Ortiz de Montellano, 1983).

4. Establishing learning situations which are experientially based. This approach helps students in learning how to develop inquiry skills by setting up a scientifically challenging situation which stimulates creative problem-solving. For example, scholastic games in which teams of students solve futuristic problem scenarios through the creative application of their knowledge provides an exciting alternative. Eskimo students at Gambell, Alaska have shown that they are quite capable of winning at state and international levels of future problem solving competitions. Contrary to myth, many American Indian students avidly participate in team competition, especially if such competitions relect group prestige. These students can excel at scientific research providing they see a clear and immediate purpose for their study. When they are allowed to look and listen first (i.e. assimilate bodies of relevant information), they can develop ideas and test approaches (Guthridge, 1986).

5. Incorporating creative writing as a part of the presentation of science/math content. Creative writing develops both the verbal and imaging capacities of students to a larger degree than the lecture-demonstration. Creative writing also provides students with the opportunity to apply the "affective dimension" of thinking to science content. By having students write about "their" thoughts and feelings in reference to such topics as overpopulation, nuclear disarmament, AIDS, energy development on reservations, and American Indian health and social problems, they learn to research, see the relevance of science and widen their own sense of engagement concerning these issues (Blake, 1985).

6. Presenting art as an ideal vehicle for creativity in science and math. At the process level, art is the mirror of science. As such, art activities stimulate students' creative capacities for visualizing, exploring and applying kinesthetic concepts. Activities involving drawing, construction or artistic exemplification of science or math concepts allow for a fuller expression of culturally-related ideas and more complete involvement in the learning process (Cajete, 1986).

7. Exploring the effects of technology on human lifestyles. Areas which may be explored include comparison/contrast of American Indian traditional technology with that of modern society, and lifestyles and the environmental impact of both cultures. Role playing, experiential learning, community research, and "what if" scenarios are all excellent methodologies for discussions. These approaches involve teaching science as a "process" which in turn helps students not only to understand scientific investigation, but also to develop sensitivity through the application of creative techniques. Teachers can help students to recognize that science and math are both creative processes and cultural systems of knowledge. Insights are gained through combining and exercising learning abilities. This is the nature of science and math "in the making" (Cajete, 1986; Iozzi, 1982).

**What general roles should the teacher, counselor and administrator play in encouraging American Indian students to excel in science and math?**

Motivation is a two way street and requires the active participation of teacher and student. The teacher's role is essential in the initial motivation of American Indian students in science and math. The teacher must begin by attempting to understand and appreciate what the American Indian student brings with him/her in the form of cultural knowledge, values, creative abilities and interests. These are the foundation for creating motivational tools and facilitating active learning. The teacher must combine affective teaching with cultural sesitivity in dealing with American Indian students. Creative teaching strategies must be implemented which more completely involve American Indian students in the thinking processes of science and math. Furthermore, the teacher must develop a working knowledge of learning styles and teach to those styles at every opportunity. Also, increased preparation in science/math education allows the teacher greater flexibility in tailoring lessons to meet the needs of American Indian students in those subjects.

The first step in the development of a strategy of motivation begins with researching American Indian cultural content related to basic concepts in science and math. The next step is incorporating instructional approaches into the curriculum which utilize local environmental, cultural and community resources to further enhance the teaching for motivation and interest by the American Indian learner.

Finally, counselors and administrators must play an active role in informing American Indian students of academic requirements and related careers in science/math along with improving their own understanding of science related professions. This can be accomplished by facilitating personal contacts between students, science/math teachers, and American Indian science professionals. In addition, administrators must make a tangible commitment in supporting teachers, curriculum and program development focused on improving the performance and self-image of American Indian students. Motivating American Indian students in science and math requires continuous enthusiasm, high expectations, and commitment on the part of teachers, counselors, and administrators. It is challenging but it can achieve the result of getting American Indian students excited and eager to learn about science and math.

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ERIC DIGEST

# AMERICAN INDIAN EDUCATION

EDO-RC-88-02

## MOTIVATING AMERICAN INDIAN STUDENTS IN SCIENCE AND MATH

BY

GREGORY A. CAJETE

JANUARY 1988



ERIC® CLEARINGHOUSE ON RURAL EDUCATION and SMALL SCHOOLS

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